

# EXPLORE SCIENCE

## Exploration Science Strategy and Integration Office (ESSIO)

BPAC

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**Dr. Brad Bailey**

Assistant Deputy Associate Administrator for Exploration (ADAAX)  
Science Mission Directorate, NASA



# CLPS Deliveries

## 2023-2026

**Delivery Site:**  
Gruithuisen Domes  
Provider TBD  
CP-21 | 2026

**Delivery Site:**  
NE Oceanus  
Procellarum near  
Gruithuisen Domes  
**Provider:** Astrobotic  
TO2-AB | Q1 2023

**Delivery Site:**  
Lunar Far Side &  
Orbit Insertion  
Provider TBD  
CS-3 | 2025

**Delivery Site:**  
Reiner Gamma  
**Provider:** IM  
CP-11 | 2024

**Delivery Site:** South Pole Region  
**Provider:** Intuitive Machines (IM)  
TO2-IM | Q1 2023

**Delivery Site:**  
Mare Crisium  
**Provider:** Firefly  
TO19D | 2024

**Delivery Site:**  
Shackleton Connecting  
Ridge **Provider:** IM  
TO PRIME-1 | Q3 2023

**Delivery Site:**  
Nobile Crater  
**Provider :** Astrobotic  
VIPER | Nov 2024

**Delivery Site:**  
Schrödinger Basin  
**Provider:** Draper  
CP-12 | 2025

**Delivery Site:**  
South Polar Region  
Provider TBD  
CP-22 | 2026

**Delivery Site:**  
Haworth Crater  
**Provider:** Masten  
TO19C | Nov 2023

# Commercial Lunar Payload Services (CLPS)

- CLPS is an innovative, service-based, competitive acquisition approach that enables rapid, affordable, and frequent access to the Lunar surface via a growing market of American commercial providers
- Service task orders are Firm Fixed Price (FFP) for the full scope of delivery: from payload hand-over to delivery (and often operation) on the lunar surface
  - All payload requirements must be captured in the originating Request for Task Plan (RFTP)
- NASA wants to be one of many customers for CLPS services
- CLPS deliveries are CLPS Provider missions (not NASA missions)
- CLPS launches are commercial launches provided via the CLPS provider and approved/licensed by the U.S. Gov't FAA (Federal Aviation Administration) and other agencies (not NASA)



# CLPS Contract and Portfolio

- Competition open to U.S. commercial providers of space transportation services, consistent with National Space Transportation Policy and Commercial Space Act
- Structured for NASA as one of many customers of commercial service
- On ramps to the CLPS contracts will be used to provide additional capabilities as made available
- 14 domestic companies eligible to compete for Lunar surface delivery task orders
- 8 awarded lunar surface deliveries actively in work with initial deliveries as soon as Q1 2023.

CP-12 2025  
Draper  
SERIES-2 Lander



## Initial CLPS companies (Nov 2018):

- Astrobotic
- Deep Space Systems
- Draper
- Firefly Aerospace
- Intuitive Machines
- Lockheed Martin Space
- Masten Space Systems
- Moon Express
- Orbit Beyond

## First On-Ramp (Nov 2019):

- Blue Origin
- Ceres Robotics
- Sierra Nevada Corporation
- SpaceX
- Tyvak Nano-Satellite Systems, Inc.

TO2 2022  
Astrobotic  
Peregrine



TO2/20C 2022  
Intuitive Machines  
NOVA-C



TO19C 2023  
Masten  
XL-1



TO PRIME-1 2022  
Intuitive Machines  
NOVA-C



TO20A 2023  
Astrobotic  
Griffin



TO19D 2023  
Firefly Aerospace  
Blue Ghost



CP-11 2024  
Intuitive Machines  
NOVA-C



# New CLPS Contract Awarded

- NASA awarded CLPS contract (CP-12) to Draper of Cambridge, Massachusetts for delivery of Artemis science investigations to Schrödinger Basin in 2025
- Instruments selected for this flight include
  - Farside Seismic Suite (FSS)
  - Lunar Interior Temperature and Materials Suite (LITMS)
  - The Lunar Surface ElectroMagnetics Experiment (LuSEE)
- These experiments riding on Draper's SERIES-2 lander are headed to Schrödinger Basin, a large lunar impact crater on the far side of the Moon, close to the lunar South Pole.



Operations from the far side of the Moon will help improve how we track activities from this location to address scientific goals – all while we gather data from the payloads

*Chris Culbert; CLPS program manager at NASA'*



*An illustration of Draper's SERIES-2 lunar lander; to carry CP-12 in 2025*



*Schrödinger Basin, to receive SERIES-2 lunar lander; to carry CP-12 in 2025*

# CLPS Payload Services

- NASA-owned and sponsored payloads are:
  - Manifested by a CLPS Manifest Selection Board with multi-Directorate representation
  - Assigned Payload Integration Managers and Project Scientists to guide integration and maximize science
  - Designed to advance science, technology, and exploration through investigations
- After payload handover, CLPS providers are responsible for integration, delivery, deployment and/or operation of customer payloads on the lunar surface
- CLPS providers secure all necessary hardware, systems, facilities and services to perform the delivery
  - NASA LSP (Launch Services Program) is not engaged in launch vehicle acquisition
  - DSN (Deep Space Network) (if required by contractor) is acquired by provider via RSAA (Reimbursable Space Act Agreement)
- Payload service tasks may include:
  - Physical operation, release/deployment with or without wireless/tethered services, passive delivery, and/or direct delivery into specified lunar orbit, augmented insight

# Payload Accommodations

- Providers are required to “accommodate” the needs of NASA payloads, including:
  - Utilities: power, data, commanding, etc.
  - Mounting: fields of view, alignments, co-locations, etc.
  - Environments: thermal, vibe, emi/emc, etc.
  - Operations: conops, mission phases, etc.
- CLPS Task Orders are generally awarded competitively; payloads should therefore not be designed for a specific CLPS provider
- Firm Fixed Price (FFP) Task Orders necessitate stable definition of interfaces and requirements PRIOR to release of the Request for Task Plan (RFTP)
  - If it is not defined in the RFTP then it is defined de facto by the CLPS provider, or else is a “new” requirement at a cost
  - If requirements cannot be finalized, RFTP should specify achievable envelope for both sides to work toward
  - “Requirements” in an FFP procurement environment are what you are going to get, so RFTP requirements should align with what is needed for mission success



# Future Definition of CLPS

- Continue building the commercial market; CLPS service options are expected to expand as market and company capabilities evolve
  - Estimating periodic on-ramp opportunities into the CLPS Vendor Pool going forward depending upon need and service availability
  - Maintain flexibility of the CLPS IDIQ to award Task Orders for upcoming capabilities, data buys
  - SMD manifests will continue to be competitively-selected payloads
  - Expect to continue cadence of ~2 flights per year
  - Support of other mission directorates and international partners through delivery of priority science/technology investigations to the lunar surface
- Support of Artemis crewed activities through delivery of scientific equipment, supplies for longer duration missions, human-centric infrastructure (e.g., LTV, ISRU demos/equipment, etc.)
  - New capabilities that would enhance science return, ops, and open new avenues for scientific investigations
    - Mobility
    - Orbital Drop-off
    - Comm Relay
    - EMI Quiet Operation
    - Increased Delivery Mass
    - Surviving/operation throughout the lunar night
    - Articulation / Regolith Manipulation
    - PSR/Cold Operations
    - Sample Return



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TO PRIME-1 | Q3 2023

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VIPER | Nov 2024

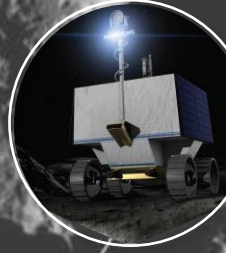
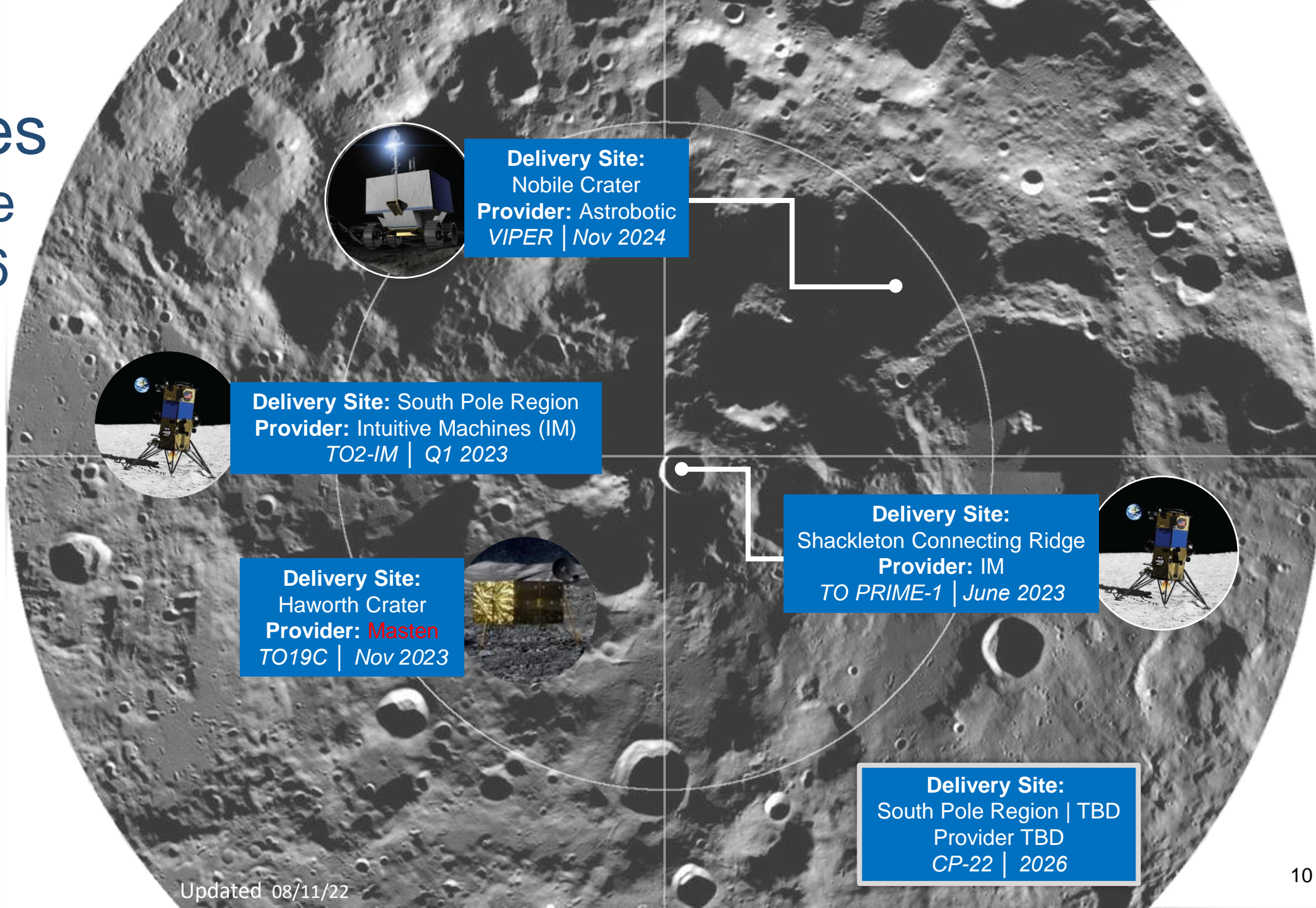
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Provider TBD  
CP-22 | 2026

**Delivery Site:**  
Haworth Crater  
**Provider:** Masten  
TO19C | Nov 2023



# CLPS Deliveries South Pole 2023-2026



**Delivery Site:**  
Nobile Crater  
**Provider:** Astrobotic  
*VIPER | Nov 2024*



**Delivery Site:** South Pole Region  
**Provider:** Intuitive Machines (IM)  
*TO2-IM | Q1 2023*

**Delivery Site:**  
Haworth Crater  
**Provider:** Masten  
*TO19C | Nov 2023*



**Delivery Site:**  
Shackleton Connecting Ridge  
**Provider:** IM  
*TO PRIME-1 | June 2023*



**Delivery Site:**  
South Pole Region | TBD  
Provider TBD  
*CP-22 | 2026*

# Science Highlights of Early Task Orders

## **TO2 AB**

- Characterize volatile composition of regolith and exosphere during and after landing and over the course of the lunar day (SEAL, NIRVSS, MSolo, PITMS, NSS, NMLS)
- Characterize the local radiation environment (LETS, NMLS)

## **TO2 IM**

- Determine the photoelectron sheath density and scale height (ROLSSES)
- Characterize plume-surface interactions during landing (SCALPSS)

## **19C Masten**

- Characterize volatile composition of regolith and exosphere during and after landing and over the course of the lunar day (NIRVSS, MSolo, NSS)
- Characterize the terrain, surface mineralogy, composition, and thermophysical properties of the lunar surface (Heimdall, L-CIRiS)
- Characterize the local radiation environment (LETS)

## **19D Firefly**

- Characterize Earth's magnetosphere (LEXI)
- Characterize structure, composition, and thermal properties of the Moon's interior (LMS, LISTER, NGLR)

## **CP-11 (PRISM 1a)**

- Study the magnetic and plasma environment within a lunar swirl to address the origin of magnetized crust, origin of swirls, and nature of space weathering on airless bodies (Lunar Vertex, MPaC, LUSEM)

## **CP-12 (PRISM 1b)**

- Use geophysical techniques to characterize the Moon's interior to understand how the Moon differentiated and evolved into its current state (FSS, LITMS, LuSEE)

## **CP-21 (PRISM 2a)**

- Study the silicic volcanic constructs at Gruithuisen Domes (Lunar-VISE)

## **CP-22 (PRISM 2b)**

- Study environmental monitoring and/or biological sciences at the lunar south pole (LEIA)



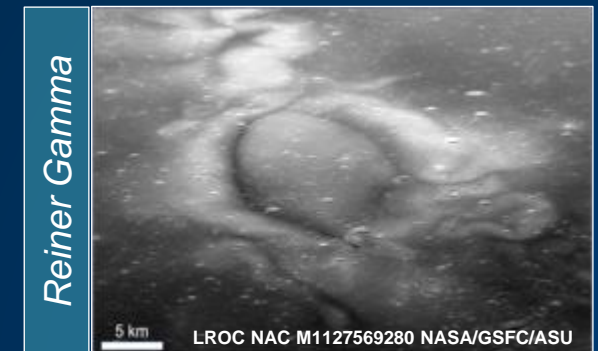
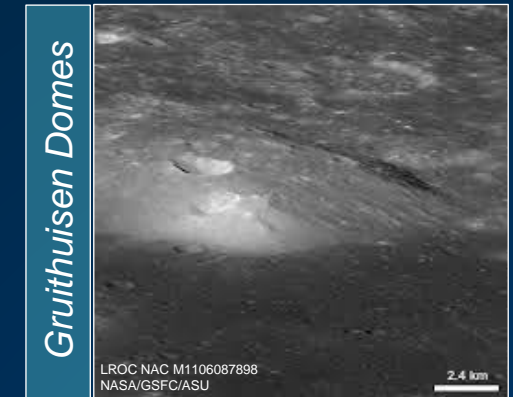
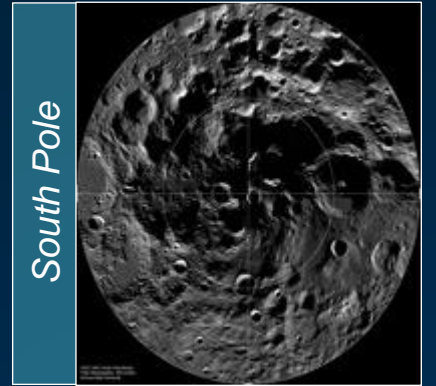
# Payloads and Research Investigations on the Surface of the Moon (PRISM)

PRISM is SMD's primary way of selecting science payloads for delivery via CLPS.

- Annual ROSES call for PI-led suites of instruments (7120.8)
- Nominally ~\$30M per delivery for payloads, including phases A-F, instrument development, engineering, ops, science, data archival
- Solicitation will identify site specific vs site agnostic instruments desired

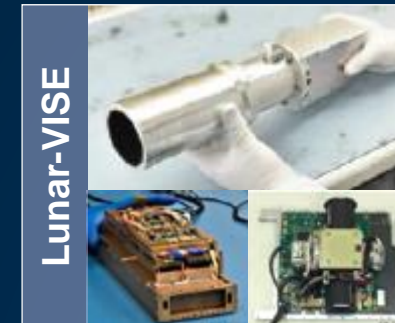
## PRISM 1

- Task Order CP-11: Lunar Vertex will land at Reiner Gamma, a lunar swirl feature on the near side, in 2024 with 2 partnered international payloads: ESA's MoonLIGHT Pointing Actuator (MPAc) and KASI's Lunar Space Environment Monitor (LUSEM)
  - **Planetary decadal science:** Understand how lunar surface has been modified by geological processes within a lunar magnetic anomaly and determine the origin of magnetized crust
- Task Order CP-12: Farside Seismic Suite (FSS) and Lunar Interior Temperature and Materials Suite (LITMS) will land at Schrödinger Basin, the first CLPS lunar farside delivery
  - **Planetary decadal science:** Characterize differentiation and evolution of the Moon's interior using geophysical techniques



# Payloads and Research Investigations on the Surface of the Moon (PRISM)

- PRISM-2
  - Lunar Vulkan Imaging and Spectroscopy Explorer (Lunar-VISE) will land at Gruithuisen Domes, to study geologic processes preserved on the Moon, by investigating rare lunar volcanism | PI: K. Donaldson Hanna
    - **Planetary decadal science:** How do the interiors of solid bodies evolve, and how is this evolution recorded in a body's physical and chemical properties? How are solid surfaces shaped by subsurface, surface, and external processes?
  - Lunar Explorer Instrument for space biology Applications (LEIA) will land near south pole to study the biological response of yeast to the environment and determine how partial gravity and deep space radiation influence biological processes | PI: A. Settles
- PRISM-3 solicitation text was released via ROSES-22 in Sept 2022. Step-2 proposals due Dec 20, 2022
  - Proposers must specify non-polar landing site (< 75d N/S)



# Upcoming Lunar Solicitations



The following are expected solicitations out of SMD's Lunar Discovery and Exploration Program (LDEP) within the calendar year\*

## Artemis III/IV

- Artemis III Geology Team
- Deployed Instruments Call – Includes Surface deployed instruments, lander mounted instruments, and/or Astronaut-utilized instruments

## PRISM-3

- For the next CLPS delivery to a) a south polar location and b) a TBD location



*LTV mounted*



*Astronaut Utilized*



*Lander mounted*



*Astronaut Deployed*

\*A community announcement will be released ~3 months prior to all solicitations



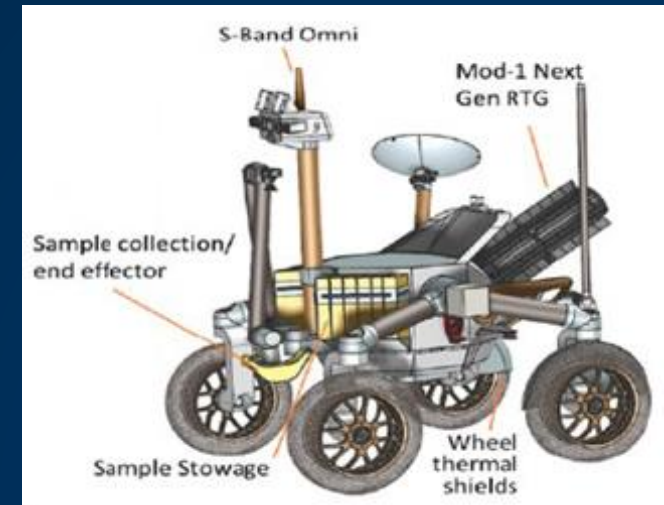
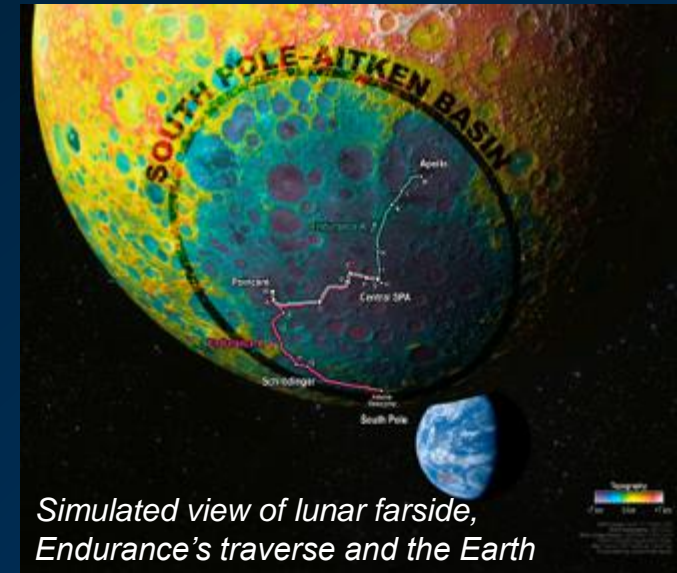
# Planetary Science Decadal Survey

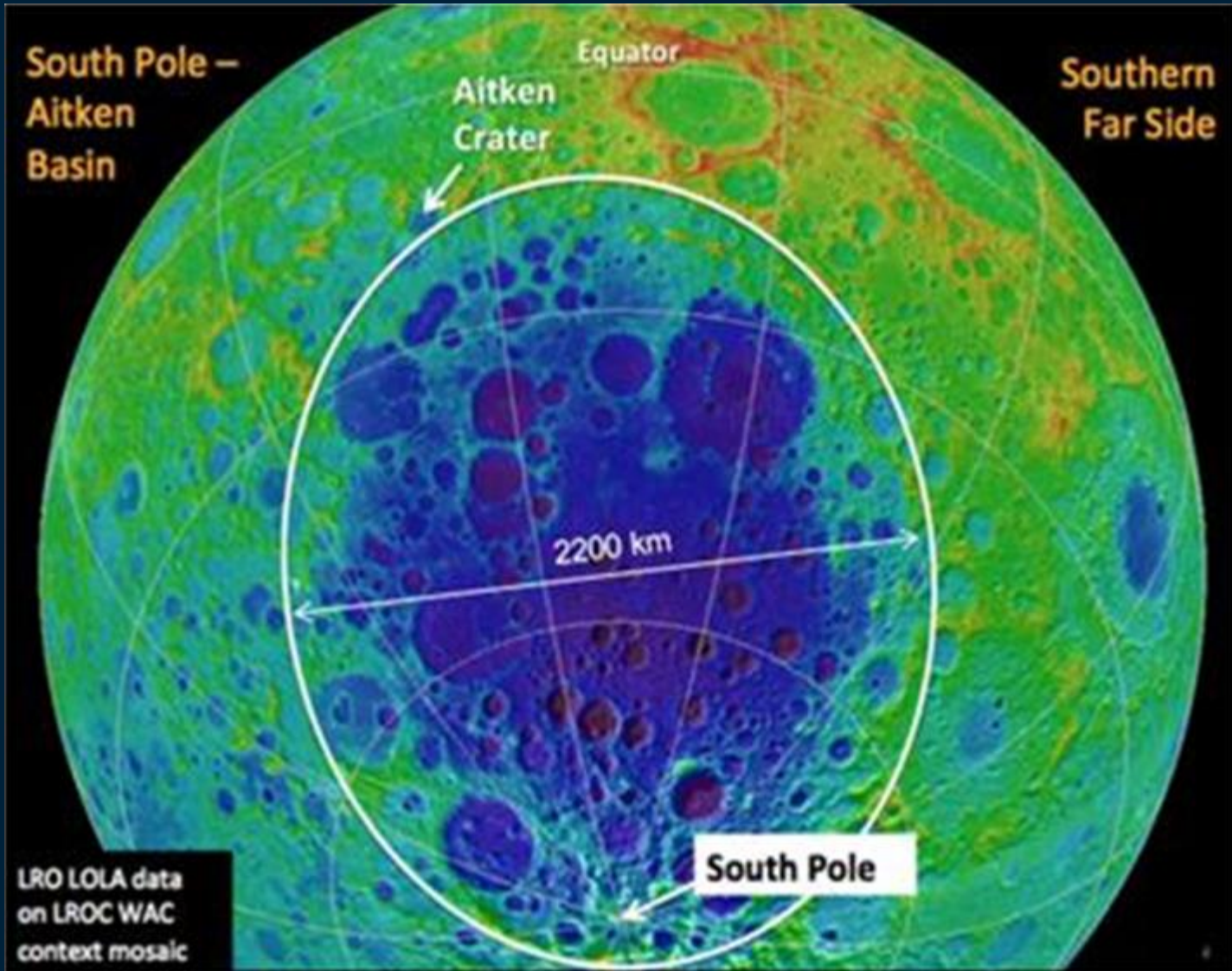
## Endurance A: South Pole-Aitken Sampling Campaign

- One of the top lunar priorities of the Planetary Decadal is Endurance A, a long-duration rover capable of traversing ~2000km and returning ~100kg of samples taken at strategic sites throughout the South Pole-Aitken basin to investigate several lunar science objectives:
  - Solar System Chronology: Anchors the earliest impact history of the Solar System, tests the giant planet instability, impact cataclysm, and late heavy bombardment hypotheses, and anchors the “middle ages” of solar system chronology
  - Planetary Evolution: Tests the lunar magma ocean hypothesis, characterizes the thermochemical evolution of terrestrial planets, and explores the geologic diversity of a giant impact basin from floor to rim

**Recommendation:** Endurance-A should be implemented as a strategic medium-class mission as the highest priority of the Lunar Discovery and Exploration Program. Endurance-A would utilize CLPS to deliver the rover to the Moon, a long-range traverse to collect a substantial mass of high-value samples, and astronauts to return them to Earth.

– *Origins, Worlds, and Life (Planetary Decadal)*, 22-17





# South Pole-Aitken (SPA) Basin: Crucial Destination for Solar System Science

A unique location on the Moon and in the Solar System

- SPA is the largest, oldest, clearly recognizable lunar impact basin
- SPA impact completely resurfaced a large part of the Moon and reset ages over an enormous area
- SPA anchors the lunar impact chronology

The determination of SPA basin formation age and chronology is crucial science



National Aeronautics and  
Space Administration



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